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EP 0788930 A1
EP 0511427 A1
US 6217090 A
US 5799991 A
US 3857595 A
US 3718332 A

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(54) Abstract Title
Vehicle bumper assembly

(57) A bumper assembly 4 for a motor vehicle (10, Fig 2) is disclosed in which the crush resistance of a deformable structure 7 can be varied to optimise the impact performance of the bumper assembly 4. The impact or crush resistance is varied by changing the resistance to flow of fluid 25 through a component 15 operatively connected to a member 22 forming part of the deformable structure 7.

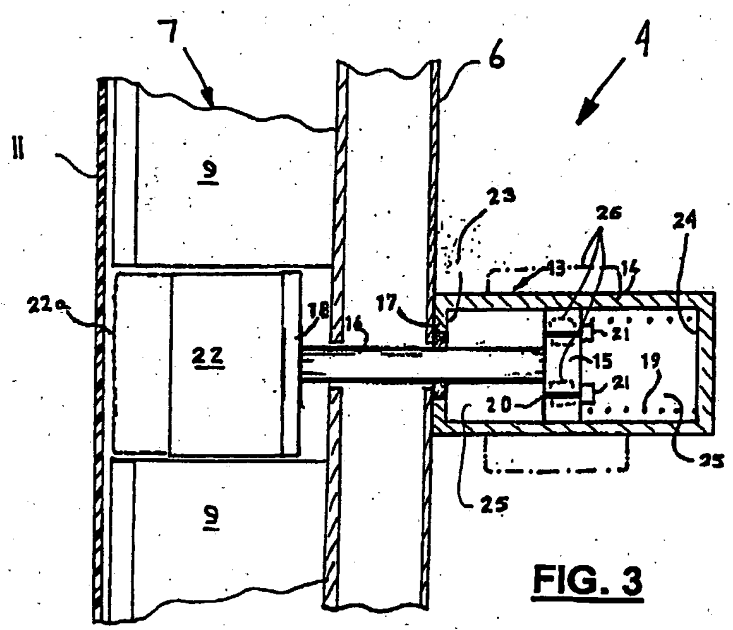

FIG. 3

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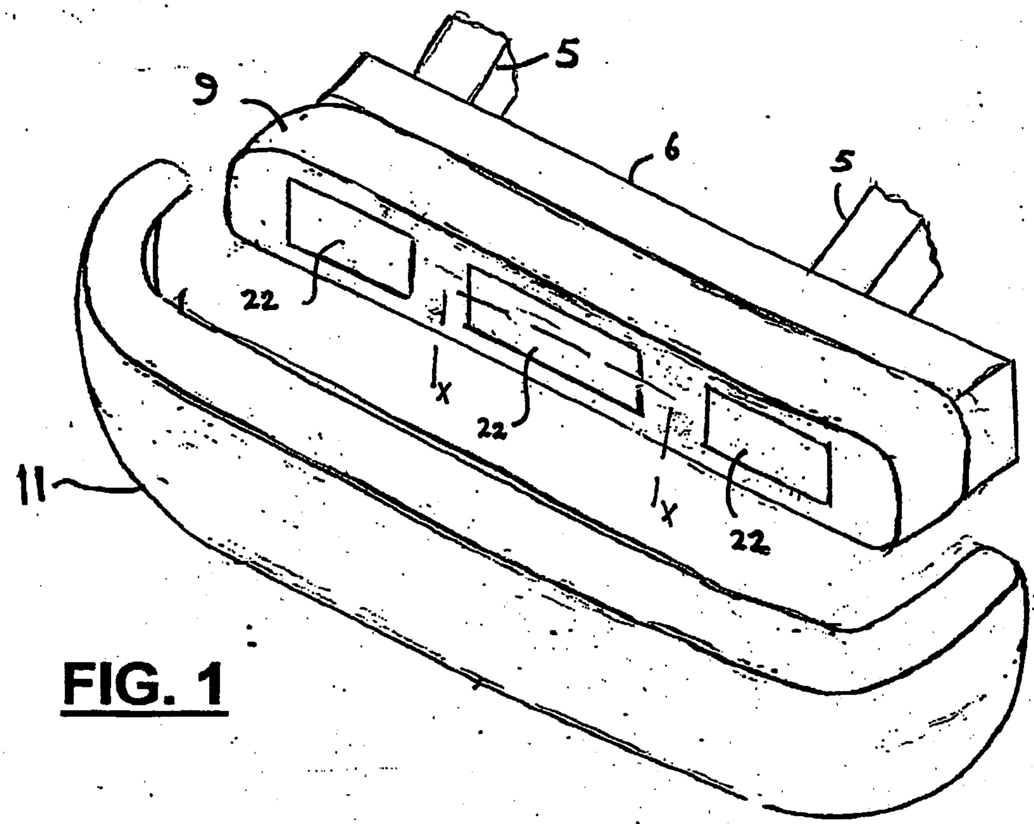
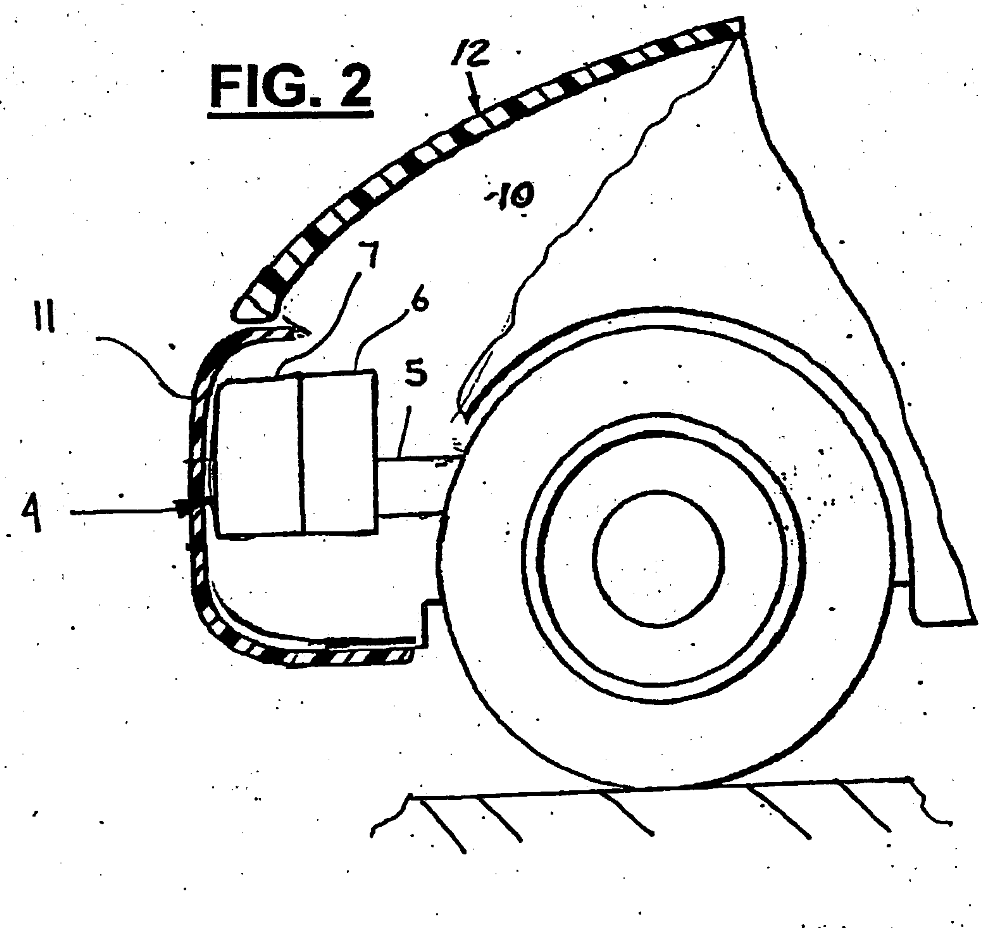


FIG. 1

FIG. 2



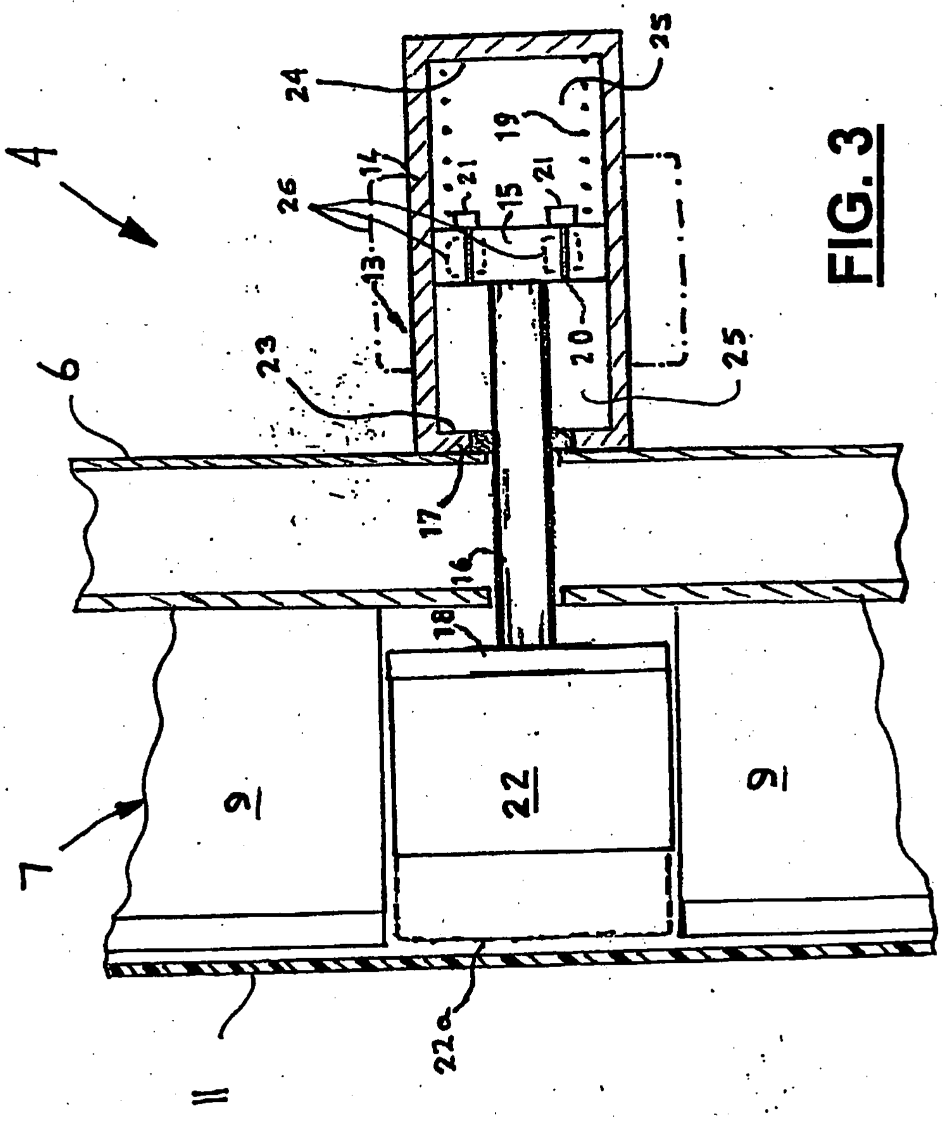


FIG. 3

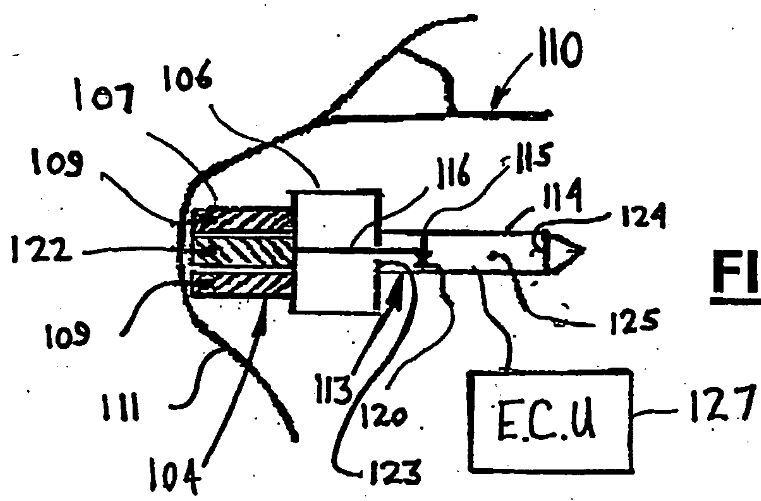


FIG. 4

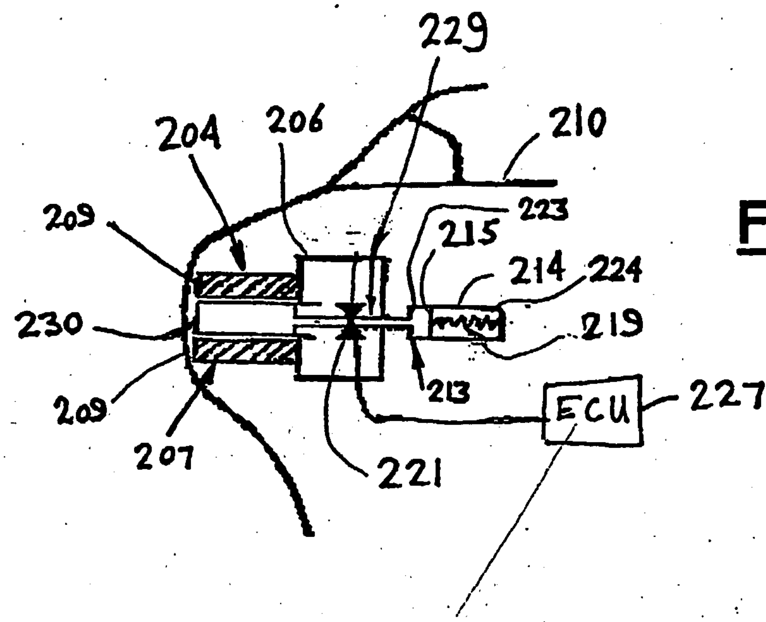


FIG. 5

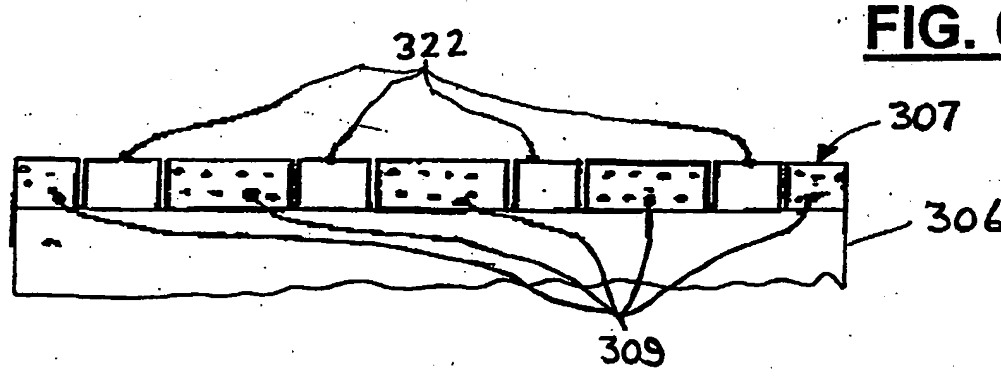


FIG. 6

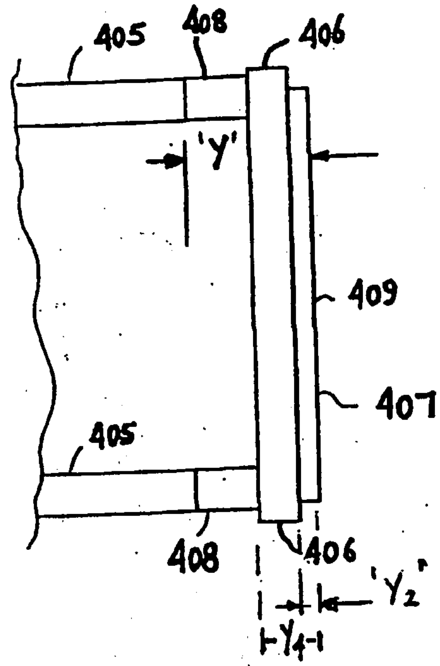

405
408
406
'y'
409
407
405
408
406
'Y_2'
Y_1

FIG. 7

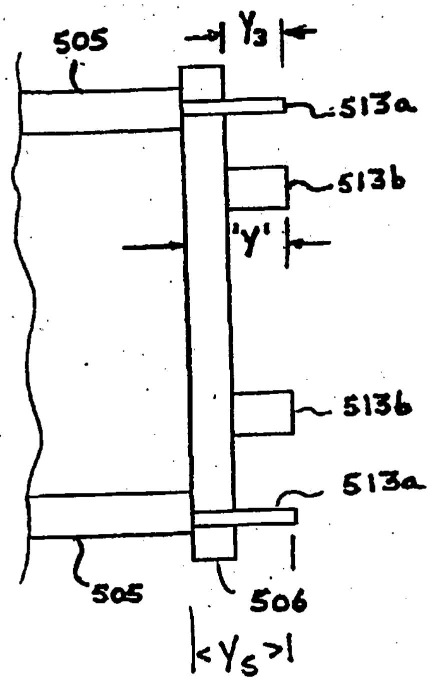

505
Y_3
513a
513b
'y'
513b
513a
505
506
Y_5

FIG. 8

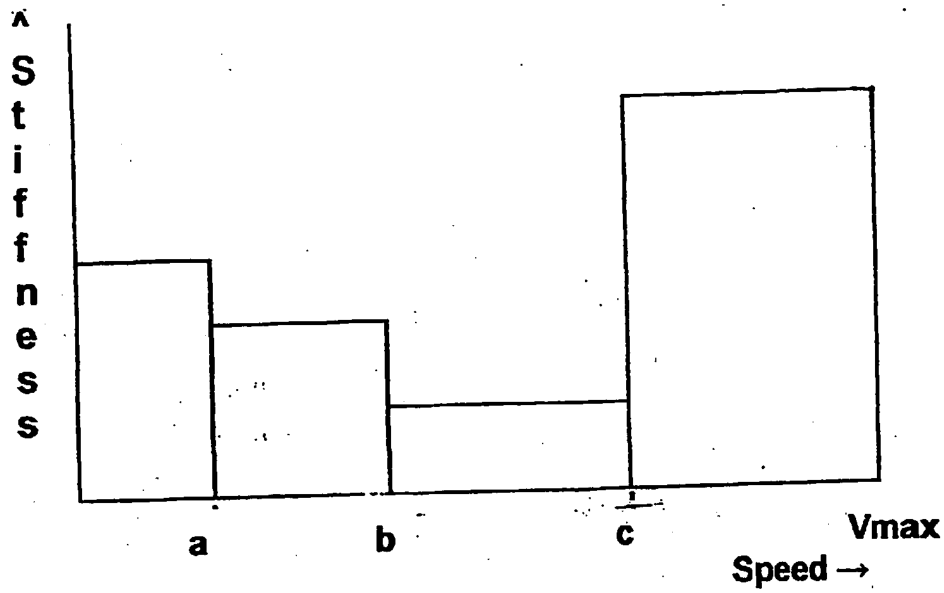


FIG. 9

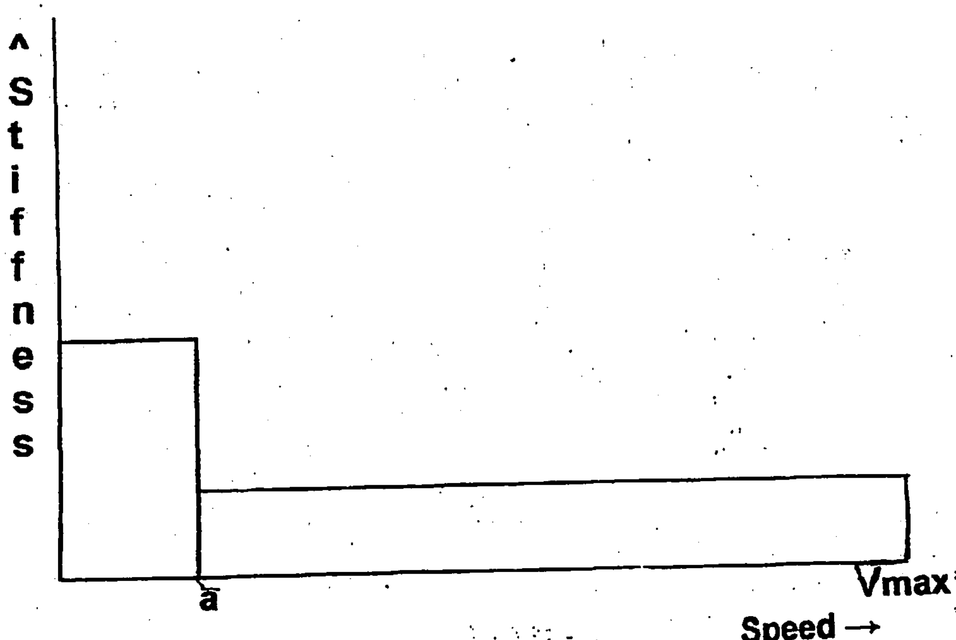


FIG. 10

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A vehicle bumper assembly

This invention relates to vehicle bumper assemblies and in particular to a bumper assembly having selectable impact properties.

It is well known to provide a vehicle with a bumper assembly to absorb energy when the vehicle impacts against another object such as may occur if the vehicle is involved in a collision. The constraints placed upon a vehicle designer make the design of such bumper assemblies increasingly more difficult because of the need to satisfy several conflicting requirements. In many countries there is a requirement that for minor collisions, up to approximately 8 KPH (5 mph), the bumper assembly must protect the vehicle with no permanent damage to its safety systems. To achieve this, the designer is required to provide a deformable member with a relatively high crush resistance so that the deformation that occurs is minimal at these low speeds.

There is also an increasing need to provide a more pedestrian friendly characteristic to the bumper assembly such that in the event of an impact of the vehicle with a pedestrian the injuries to the pedestrian are minimised. To achieve this it is desirable to provide a deformable member having a relatively low crush resistance so that a large amount of deformation will occur when impacted by a relatively small force of the magnitude corresponding to that of an impact with a pedestrian. At high speed the requirement is for a high crush resistance so that a large force is required to create deformation.

Prior art bumper assemblies often utilise two components to try and achieve the above requirements: a deformable member, which is normally made from foam or a plastic structure, and a support structure in the form of a

transverse beam. In the event of a low speed impact the deformable member is able to absorb the relatively low forces and provide the no damage properties required from the bumper assembly and at high speeds the transverse beam is itself deformed to provide an energy absorbing structure of high crush resistance. However, such prior art bumper assemblies are not optimised for impact with a pedestrian and so the crush resistance of the deformable member is higher than is desirable in order to minimise injuries.

It is an object of this invention to provide a bumper assembly for a vehicle that is more readily optimised for all eventualities.

According to a first aspect of the invention there is provided a bumper assembly for a vehicle, the assembly comprising a deformable structure to absorb energy in the event of an impact between the vehicle and another object and a support structure to transfer load from the deformable structure to a structural part of the vehicle, wherein the deformable structure includes at least one energy absorbing member of uniform crush resistance and at least one energy absorbing member of selectable impact resistance such that the crush resistance of the deformable structure is changeable between at least a relatively low crush resistance and a relatively high crush resistance and wherein the crush characteristics of the or each selectable impact resistance member is varied in relation to the speed of the vehicle. There may be several of such selectable impact resistance members.

The energy absorbing member of uniform crush resistance may be made from foam, a honeycomb material or be a deformable structure made of plastic or metal or a combination of both.

The crush characteristic of the or each selectable impact resistance member may be varied to have a relatively high impact resistance below a first predetermined vehicle speed and a relatively low impact resistance above the first predetermined vehicle speed.

The or each selectable impact resistance member may be varied to have a low impact resistance between a first predetermined vehicle speed and a second higher predetermined vehicle speed and a high impact resistance above the second predetermined vehicle speed. Furthermore, the or each selectable impact resistance member may be varied to have a relatively high impact resistance below a first predetermined vehicle speed, a relatively low impact resistance between the first vehicle predetermined speed and a third higher predetermined vehicle speed, a very low impact resistance between the third predetermined vehicle speed and a higher second predetermined speed and a high impact resistance above the second predetermined vehicle speed. The third predetermined vehicle speed may be in the range 15 to 20 kph and preferably 18 kph and the second predetermined vehicle speed may be in the range 40 to 80 kph. The first predetermined speed may be in the range 6 to 10 kph, typically 8kph.

The or each selectable impact resistance member may comprise a piston slidably supported within a sealed cylinder, a working fluid contained within the cylinder, control means to selectively change the resistance to flow of the fluid from one side of the piston to the other side of the piston a movable buffer member forming part of the deformable structure and a shaft connecting the buffer member to the piston.

Preferably, a spring is provided to bias the piston towards the end of the cylinder nearest to the buffer member

so as to maintain the buffer member in an extended position during normal use.

Alternatively, the or each selectable impact resistance member may comprise a piston slidably supported within a sealed cylinder, a working fluid contained within the cylinder on one side of the piston, a collapsible member filled with fluid, a conduit connecting the collapsible member to a first end of the cylinder, a spring to bias the piston towards the first end of the cylinder and a control means to selectively change the resistance to flow of the fluid from the collapsible member to the cylinder.

The control means may be a variable orifice, in which case, the control means may further comprise an electronic control unit to control the variable orifice dependent upon the speed of the vehicle.

Alternatively, the fluid may be an electro-rheological fluid of variable viscosity and the control means may comprise an electric field means to apply an electric field to the fluid, in which case the control means may further comprise an electronic control unit to control the electric field means dependent upon the speed of the vehicle.

As yet a further alternative, the fluid may be an magneto-rheological fluid of variable viscosity and the control means may comprise a magnetic field means to apply a magnetic field to the fluid, in which case the control means may further comprise an electronic control unit to control the magnetic field means dependent upon the speed of the vehicle.

According to a second aspect of the invention there is provided a vehicle including a bumper assembly in accordance with the first aspect of the invention.

The invention will now be described by way of example with reference to the accompanying drawing of which:-

Fig.1 is a pictorial view of a first embodiment of a bumper assembly according to the invention;

Fig.2 is a cutaway side view of a front portion of a motor vehicle having a bumper assembly according to the invention;

Fig.3 is a view along the line X-X on Fig.1 showing a selectable energy absorbing member according to the invention in a post impact position;

Fig.4 is a schematic view of a second embodiment of a bumper assembly according to the invention;

Fig.5 is a schematic view of a third embodiment of a bumper assembly according to the invention;

Fig.6 is a part plan view of a deformable structure and support structure forming part of a bumper assembly according to the invention;

Fig.7 is a schematic plan view of a prior art bumper assembly;

Fig.8 is a schematic plan view of a bumper assembly in accordance with the invention showing the use of selectable energy absorbing members 513a and 513b of differing stiffness characteristics;

Fig.9 is a graph of stiffness against vehicle speed for the selectable energy absorbing member 513a shown in Fig.8; and

Fig.10 is a graph of stiffness against speed for the selectable energy absorbing member 513b shown in Fig.8

With particular reference to Figs. 1 to 3, there is shown the front end portion of a motor vehicle 10 having an engine compartment cover or bonnet 12 and a bumper fascia 11. A bumper assembly 4 is attached to a structural part of the vehicle 10 via two longitudinally extending side rails 5, the bumper assembly comprising a deformable structure 7 and a support structure in the form of a transversely extending beam 6. The beam 6 is used to support the

deformable structure 7 and to connect the bumper assembly 4 to the vehicle 10, being attached by welding, bolts, rivets or any other suitable means to the side rails 5.

The deformable structure 7 comprises two distinct energy absorbing members: a first energy absorbing member in the form of a foam member 9 and three second energy absorbing members in the form of buffer members 22. Each buffer 22 forms part of a selectable energy absorbing member 13, the impact resistance of which is variable. It will be appreciated that other deformable structures could be used instead of the foam material such as a honeycomb or a deformable structure made of metal or plastic or a sandwich construction.

Each of the selectable impact resistance members 13 comprises a piston 15 slidably supported within a sealed cylinder 14 and a shaft or piston rod 16 connecting the buffer member 22 to the piston 15. The buffer member 22 is a relatively high impact resistant member made from a polymer or metal material and is connected to the piston rod 16 by means of a support plate 18. The piston rod 16 passes through a seal 17 which is supported in a first end face 23 of the cylinder 14. The seal 17 is used to contain a working fluid 25 within the cylinder 14. A spring 19 is interposed between one side of the piston 15 and a second end face 24 so as to bias the piston 15 towards the first end face 23 of the cylinder 14. The piston 15 has a number of holes 20 which allow the fluid to flow from one side of the piston to the other side of the piston 15 when the piston is moved in the cylinder 14.

A control means in the form of flow restrictor valves 21 are provided to selectively change the resistance to flow of the fluid from one side of the piston 15 to the other side of the piston 15. The valves 21 in combination with the holes 20 form a variable orifice, the cross-sectional

area of which can be selectively changed. The valves 21 are controlled by an electronic control unit (not shown).

During normal use the buffer means 22 is position in a forward position corresponding to the dotted outline 22a. As shown, the buffer means 22 is in a post-impact position in which it has been displaced rearwardly from a normal position.

If the vehicle 10 impacts another object in the region of one of the buffer members 22 then the buffer member 22 will move rearwardly towards the beam 6, simultaneously with any crushing of the foam that occurs due to the impact. The rearward motion of the buffer member 22 is resisted by the fluid 25 contained in the cylinder 14 and the level of resistance will depend primarily upon how freely the fluid can flow from one side of the piston 15 to the other.

If the valves 21 are fully open, the fluid can flow freely across the piston 15 and the energy absorbing member 13 will have a relatively low impact or crush resistance. That is to say, a relatively small force applied to the buffer member 22 will cause the piston 15 to be moved towards the second end face 24 of the cylinder 14. Such a small force may for example be indicative of an impact with a pedestrian.

If the valves 21 are partially closed, then the fluid cannot flow so freely across the piston 15 and the energy absorbing member 13 will have a relatively high impact or crush resistance. That is to say, a higher force is required to move the piston 15 towards the second end face 24. Such a force may be of a level typical of an impact of the vehicle with another vehicle or a rigid object at low speed in the range of say 6 to 10kph.

If the valves 21 are closed or nearly closed then the fluid can flow hardly at all across the piston 15 and the energy absorbing member 13 will have a high crush resistance. In this case, the bumper means 22 is likely to stay in position and be crushed by the force applied to it. That is to say the very high force that is required to move the piston 15 towards the second end face 24 is greater than the crush resistance of the bumper means 22. Such high forces are likely to be applied when the vehicle impacts another vehicle or solid object at high speed.

It will be appreciated that an impact with another object is a short term event and that after the impact is over the force applied to the bumper member soon returns to zero. The spring 19 is then operable to return the piston 15 and hence the bumper member 22 to its starting position 22a, provided that the impact was not severe, in which case the bumper member 22 will probably have been crushed.

An electric control unit (not shown) is connected to the valves 21 and is operable to vary the crush resistance of the energy absorbing members 13 depending upon the forward velocity of the motor vehicle 10. At speeds up to, say, 8 kph, the electronic control unit is operable to place the valves 21 in a position in which the impact or crush resistance of the energy absorbing member 13 is relatively high. In this condition an impact with another object will result in little deformation of the bumper assembly 4 and the force will be taken primarily by the selectable energy absorbing members 13. At such low speeds the flexibility in the bumper fascia cover 11 is sufficient to provide some protection in the event of an impact with a pedestrian and the relatively high resistance provided by the selectable energy absorbing members 13 means that the overall crush resistance of the deformable structure 7 is sufficient to resist damage to the bumper assembly 4.

When the vehicle speed exceeds 8kph, the electronic control unit is operable to open the valves 21 so that the crush resistance of the energy absorbing members 13 is relatively low. While in this state an impact with another object will be resisted primarily by the foam 9 which is a low stiffness material providing a relatively low crush resistance. Therefore, if the vehicle impacts a pedestrian in this state, a relatively soft impact will occur. This is likely to cause less damage to a person than an impact with a rigid or stiff bumper assembly.

In the event of an impact with a solid object such as another vehicle the foam 9 will be easily crushed but the buffer means 22 are stiffer and will be deformed to provide some crush deformation and hence energy absorption when the travel of the piston 15 is exhausted.

If desired, the electronic control unit can be operable to close the valves 21 completely above a predetermined speed such as 80 kph so that the energy absorbing members 13 have a high crush resistance. This may be beneficial to the occupants of the vehicle if an impact with another vehicle were to occur at such a high speed by effectively extending the rail to the forward face of the crushable absorbing elements 7.

It will be appreciated that the invention revolves around the use of a variable stiffness member and, although the use of a member having only a few different stiffness change points is described, the member could have a large number of stiffness change points as required by the vehicle or it could be infinitely variable with a performance determined by a function map or could be configured to respond prior to an impact by linking it to a pre-crash sensor.

It will further be appreciated that other means could be used to vary the resistance to flow of the fluid. For example, a rheological fluid having variable viscosity such as a magneto-rheological fluid or an electro-rheological fluid could be used.

In the case of magneto-rheological fluid, the valves 21 would be replaced by one or more electromagnets (shown in dotted outline on Fig.3 as 26). Depending upon the fluid used, the application of a magnetic or electric field to the fluid could be used to increase or decrease the viscosity of the rheological fluid in the region of the applied field.

By increasing the viscosity of the fluid, its resistance to flow through the holes 20 can be increased and in this manner the selection of a desired impact or crush resistance may be obtained. It will be appreciated that various arrangements can be constructed to control the flow of fluid apart from those described above which are merely illustrative of preferred methods. For example, the connection between opposite sides of the piston could be made by external conduits rather than apertures in the piston. As before, an electronic control unit would be used to control the impact or crush resistance of the energy absorbing member 13 dependant upon or related to the speed of the vehicle.

It will be appreciated that the crush resistance of the energy absorbing member 13 could be variable in other patterns to that described above but that the above selection of crush characteristics is particularly suitable to meet regulatory requirements and provide optimised safety for the passengers of the vehicle and for pedestrians involved in an impact with the vehicle.

With particular reference to Fig.4, there is shown a second embodiment that is in most respects identical to that

previously described and for which identical parts are given the same reference number with the addition of 100. The bumper assembly 104 comprises a deformable structure 107 and a support structure in the form of a transversely extending beam 106 used to connect the bumper assembly 104 to the vehicle 110. The deformable structure 107 comprises two distinct energy absorbing members, a first energy absorbing member in the form of a foam member 109 and a second energy absorbing member in the form of a buffer member 122 which forms part of a selectable energy absorbing member 113 having a variable impact or crush resistance.

The selectable crush resistance member 113 comprises a piston 115 slidably supported within a sealed cylinder 114 and a shaft or piston rod 116 connecting the buffer member 122 to the piston 115. The piston rod 116 passes through a first end face 123 of the cylinder 114. A spring (not shown) is interposed between one side of the piston 115 and a second end face 124 so as to bias the piston 115 towards the first end face 123 of the cylinder 114. The piston 115 has a number of holes 120 which allow the fluid to flow from one side of the piston to the other side when the piston is moved in the cylinder 114.

An electric control unit 127 is connected to the cylinder 114 and is operable to vary the electric field supplied from a source of electric power (not shown) to an electro-rheological fluid 125 contained within the cylinder. The viscosity of the electro-rheological fluid 125 is dependent upon the electric field applied to it and, as the viscosity of the electro-rheological fluid 125 is increased, the resistance to flow of the fluid 125 through the holes or orifices 120 increases, thereby increasing the crush resistance of the selectable energy absorbing member 113.

The crush resistance of the energy absorbing member 113 is controlled by the electronic control unit 127 depending

upon the forward velocity of the motor vehicle 110. At low speeds the viscosity of the fluid 125 is increased so that a relatively high impact or crush resistance is provided and at higher speeds the viscosity of the fluid 125 is reduced so that a relatively low crush resistance is provided.

With particular reference to Fig.5, there is shown a third embodiment of a bumper assembly. The bumper assembly 204 comprises a deformable structure 207 and a support structure in the form of a transversely extending beam 206 used to connect the bumper assembly 204 to a vehicle 210. The deformable structure 207 comprises two distinct energy absorbing members, a first energy absorbing member in the form of foam members 209 and a second energy absorbing member in the form of a collapsible buffer member 230 which forms part of a selectable energy absorbing member 213 having a variable crush resistance.

The selectable energy absorbing or crush resistance member 213 comprises a piston 215 slidably supported within a sealed cylinder 214 and a conduit 229 connecting the buffer member 230 to the cylinder 214 on one side of the piston 215. A spring 219 is interposed between one side of the piston 215 and a second end face 224 of the cylinder 214 so as to bias the piston 215 towards a first end face 223 of the cylinder 214. The piston 215 is movable in the cylinder 214 by fluid contained within the collapsible bumper member 230 and the conduit 229. A valve 221 is provided to control the flow of fluid through the conduit 229, the valve 221 forming a variable orifice that can be closed to increase the resistance to flow of fluid or opened to reduce the resistance to flow of fluid through the conduit 229.

The bumper member is in the form of a bellows 230 that will be collapsed or compressed when an impact force is applied to it. The resistance to crush of the bellows 230

is determined by the ease with which fluid can flow through the valve 221.

An electric control unit 227 is connected to the valve 221 and is operable to vary the position of the valve 221 depending upon the forward velocity of the vehicle 210. At low speeds the valve 221 is nearly closed so that a relatively high crush resistance is provided by the energy absorbing member 213 and at higher speeds the valve is nearly open so that a relatively low crush resistance is provided by the energy absorbing member 213. In this way the crush resistance of the deformable structure 207 can be adjusted to optimise its performance.

It will be appreciated that the valve 221 could be replaced by other means to vary the resistance to flow of the fluid through the conduit 229. For example the fluid could be an electro-rheological or magneto-rheological fluid of variable viscosity and means could be provided to apply and electric or magnetic field to the fluid to vary its viscosity.

With particular reference to Fig.6, there is shown a bumper assembly according to the invention having a deformable structure with four selectable energy absorbing members 322 extending the full height of the deformable structure and five uniform crush resistance members 309 supported by a cross-car beam 306. Such an arrangement provides a large degree of adjustability of the crush resistance of the deformable structure 307 due to the increased number of selectable energy absorbing members 322.

It will be appreciated that the uniform crush resistance members 309 are mainly used to give good pedestrian protection and so can be very soft while all other impacts can be dealt with by the selectable energy absorbing members 322. Furthermore, all of the uniform

crush resistance members 309 could be replaced by selectable energy absorbing members 322 so that no uniform crush resistance members are used.

With particular reference to Fig.7, there is shown a prior art bumper assembly having a beam 406 connected to two side rails 405 of a motor vehicle via crush cans 408. A deformable structure in the form of a foam structure 409 is attached to the front face of the beam 406 to provide a crushable member. It will be appreciated that the distance 'Y' between the front of the side rails 405 and the front face of the deformable structure 409 will directly effect the overall length of the vehicle and also the performance of the vehicle in a crash.

In order to keep the length of the vehicle to a minimum, the thickness 'Y_2'of the deformable member 409 also has to be kept to a minimum and this requires the use of a relatively stiff or crush resistant material if the bumper assembly is not to be damaged at relatively low speeds.

With reference to Fig.8, there is shown a bumper assembly according to the invention that uses four separate selectable energy absorbing members 513a and 513b. In this case, the beam 506 is connected directly to the side rails 505 and two of the energy absorbing members 513a are mounted directly to the side rails 505, or to the beam 506 directly in front of the side rails 505, and two 513b are mounted on the beam 506.

It will be appreciated that the beam 506 is not a totally rigid structure and if impacted at a mid-point will bend or deflect. However near to the side rails the beam is very stiff and can only be deformed by crushing it. By utilising such an arrangement the selectable energy absorbers 513a replace the separate crush cans (406 in Fig.7) and provide that function. It will therefore be

appreciated that the overall distance Y can be reduced. The distance Y_3 and Y_2 would be approximately, if not exactly, the same and the beam depth would also be approximately, if not exactly, the same. By utilising the characteristics of the selectable energy absorbers 513a correctly, these units, possibly in combination with the crush characteristics of the beams 506, would replace and provide the required crush can performance. This would be achieved within the distance Y_5 which would be approximately the same as, if not equal to, the distance Y_4 of the prior art bumper assembly of Fig.7. This allows the vehicle designer to either reduce the overall length of the vehicle by up to approximately the length of the crush cans (406 in Fig.7) or maintain the overall vehicle length but increase the length of the front side rails 505 to the rear of the beam 506, therefore improving the high speed crash performance of the vehicle due to the increase in rail length that can be utilised for crush distance to decelerate the vehicle.

The selectable crush performance of the absorbers 513a can be further tuned so that at high speed they mimic or work in combination with the energy absorbing crush performance of the front side rails 505. This effectively extends the front side rails 505 to the leading face of the front bumper assembly.

It will also be appreciated that utilisation of this absorber arrangement could also be applied to the rear of the vehicle for the same advantages, but not necessarily requiring the same pedestrian safety element as is associated with the front of the vehicle.

Fig.9 shows the deformation characteristics for the energy absorbers 513a. It can be seen that selectable crush resistance members 513a have a relatively high crush resistance or stiffness below a first predetermined speed 'a', a relatively low crush resistance between the first

predetermined speed 'a' and a third higher predetermined speed 'b', a very low crush resistance between the third predetermined speed 'b' and a second predetermined speed 'c' and a very high crush resistance above the second predetermined speed 'c'.

In the speed range 0 to 'a' the bumper assembly provides good resistance to minor impacts, between the speeds 'a' and 'b' the bumper assembly provides the resistance required to mimic the crushing of the crush cans, between the speeds 'b' and 'c' the bumper assembly provides optimum pedestrian impact performance and above the speed 'c' the bumper assembly provides maximum protection for the occupants of the vehicle.

The first predetermined speed 'a' is in the range of 6 to 10 kph and as shown is 8 kph, The second predetermined speed is in the range 40 to 100 kph and, as shown, is 80 kph and the third predetermined speed is in the range 15 to 20 kph and, as shown, is 18 kph.

Fig.10 shows the deformation characteristics for the energy absorbers 513b. It can be seen that selectable crush resistance members 513b have a relatively high crush resistance or stiffness below a first predetermined speed 'a' and a relatively low crush resistance above the first predetermined speed 'a'. In the speed range 0 to 'a', the bumper assembly provides good resistance to minor impacts and above the speed 'a' the bumper assembly provides optimum pedestrian impact performance. The first predetermined speed 'a' is in the range of 6 to 10 kph and as shown is 8 kph. The flexibility of the beam 506 is sufficient to provide protection for the occupants at high speeds.

Claims

1. A bumper assembly for a motor vehicle, the assembly comprising a deformable structure to absorb energy in the event of an impact between the vehicle and another object and a support structure to transfer load from the deformable structure to a structural part of the motor vehicle, wherein the deformable structure includes at least one energy absorbing member of uniform crush resistance and at least one energy absorbing member of selectable impact resistance such that the crush resistance of the deformable structure is changeable between at least a relatively low crush resistance and a relatively high crush resistance and wherein the crush characteristics of the or each selectable impact resistance member is varied in relation to the speed of the motor vehicle.

2. A bumper assembly as claimed in claim 1 in which there are several selectable impact resistance members.

3. A bumper assembly as claimed in claim 1 or in claim 2 wherein the energy absorbing member of uniform crush resistance is made from foam.

4. A bumper assembly as claimed in claim 1 or in claim 2 in which the energy absorbing member of uniform crush resistance is made from one of a honeycomb material and a deformable structure made of plastic or metal.

5. A bumper assembly as claimed in any of claims 1 to 4 in which the crush characteristic of the or each selectable impact resistance member is varied to have a relatively high impact resistance below a first predetermined speed and a relatively low impact resistance above the first predetermined speed.

6. A bumper assembly as claimed in any of claims 1 to 5 in which the or each selectable impact resistance member is varied to have a low impact resistance between a first predetermined speed and a second higher predetermined speed and a high impact resistance above the second predetermined speed.

7. A bumper assembly as claimed in any of claims 1 to 6 wherein the or each selectable impact resistance member is varied to have a relatively high impact resistance below a first predetermined speed, a relatively low impact resistance between the first predetermined speed and a third higher predetermined speed, a very low impact resistance between the third predetermined speed and a higher second predetermined speed and a high impact resistance above the second predetermined speed.

8. A bumper assembly as claimed in claim 7 wherein the third predetermined speed is in the range 15 to 20 kph.

9. A bumper assembly as claimed in any of claims 6 to 8 wherein the second predetermined speed is in the range 40 to 80 kph.

10. A bumper assembly as claimed in any of claims 5 to 9 wherein the first predetermined speed is in the range 6 to 10 kph.

11. A bumper assembly as claimed in any preceding claim wherein the or each selectable impact resistance member comprises a piston slidably supported within a sealed cylinder, a working fluid contained within the cylinder, control means to selectively change the resistance to flow of the fluid from one side of the piston to the other side of the piston a movable buffer member forming part of the deformable structure and a shaft connecting the buffer member to the piston.

12. A bumper assembly as claimed in any of claims 1 to 10 wherein the or each selectable impact resistance member comprises a piston slidably supported within a sealed cylinder, a working fluid contained within the cylinder on one side of the piston, a collapsible member filled with fluid, a conduit connecting the collapsible member to a first end of the cylinder, a spring to bias the piston towards the first end of the cylinder and a control means to selectively change the resistance to flow of the fluid from the collapsible member to the cylinder.

13. A bumper assembly as claimed in claim 11 or in claim 12 wherein the control means is a variable orifice.

14. A bumper assembly as claimed in claim 13 wherein the control means further comprises an electronic control unit to control the variable orifice dependent upon the speed of the motor vehicle.

15. A bumper assembly as claimed in claim 11 or in claim 12 wherein the fluid is an electro-rheological fluid of variable viscosity and the control means comprises an electric field means to apply an electric field to the fluid.

16. A bumper assembly as claimed in claim 15 wherein the control means further comprises an electronic control unit to control the electric field means dependent upon the speed of the motor vehicle.

17. A bumper assembly as claimed in claim 11 or in claim 12 wherein the fluid is a magneto-rheological fluid of variable viscosity and the control means comprises a magnetic field means to apply a magnetic field to the fluid.

18. A bumper assembly as claimed in claim 17 wherein the control means further comprises an electronic control unit to control the magnetic field means dependent upon the speed of the motor vehicle.

19. A motor vehicle including a bumper assembly as claimed in any of claims 1 to 18.

20. A bumper assembly for a motor vehicle substantially as described herein with reference to Figs. 1 to 3, Fig.4, Fig.5, Fig.6 or Figs. 8 to 10 of the accompanying drawings.

21. A motor vehicle substantially as described herein with reference to Figs. 1 to 3, Fig.4, Fig.5, Fig.6 or Figs. 8 to 10 of the accompanying drawings.

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21

Application No:	GB 0300851.3	**Examiner:**	Guy Robinson
Claims searched:	1 to 21	**Date of search:**	31 March 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1, 2, 5, 6, 11, 13 & 14	EP 0788930 A1	(MORTON) column 3 line 31 to 50, column 5 line 49 to column 6 line 38 & figs
X	1, 2, 5, 6, 11 & 12	EP 0511427 A1	(MISHI) column 2 lines 18 to 20 & 27 to 57, column 3 lines 16 to 26, column 4 lines 11 to 17 & figs
X	1, 2, 5 & 6	US 6217090	(BERZINJI) column 7 lines 18 to 35 & 51 to 54 & 66 to column 8 line 19 & figs
X	1, 2 & 11	US 3857595	(SOCIETE ANONYME DES USINES CHAUSSON) column 3 lines 14 to 54 & figs
X	1, 2, 5, 6 & 8	US 3718332	(G.M) column 3 line 61 to column 4 line 25, column 5 lines 42 to 52 & figs
X	1 to 6	US 5799991	(CONCEPT ANALYSIS) column 4 lines 27 to 54 & figs

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^{V}:

B7B

Worldwide search of patent documents classified in the following areas of the IPC^{7}:

B60R

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO